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CONCERNING DEEP-SEA DREDGINGS.

BY PROF. L. AGASSIZ.*

MY DEAR FRIEND:—On the point of starting for the Deep-Sea Dredging expedition, for which you have so fully provided, and which I trust may prove to be one of the best rewards for your devotion to the interests of the Coast Survey, I am desirous to leave in your hands a document which may be very compromising for me, but which I nevertheless am determined to write in the hope of showing within what limits natural history has advanced toward that point of maturity when science may anticipate the discovery of facts.

If there is, as I believe to be the case, a plan according to which the affinities among animals and the order of their succession in time were determined from the beginning, and if that plan is reflected in the mode of growth, and in the geographical distribution of all living beings; or, in other words, if this world of ours is the work of intelligence, and not merely the product of force and matter, the human mind, as a part of the whole, should so chime with it, that, from what is known, it may reach the unknown; and if this be so the amount of information thus far gathered should, within the limits of errors which the imperfection of our knowledge renders unavoidable, be sufficient to foretell what

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we are likely to find in the deepest abysses of the sea, from which thus far nothing has been secured.

I will not undertake to lay down the line of argument upon which I base my statement, beyond what is suggested in the few words preceding, namely, that there is a correlation between the gradation of animals in the complication of their structure, their order of succession in geological times, their mode of development from the egg, and their geographical distribution upon the surface of the globe. If that be so, and if the animal world designed from the beginning has been the motive for the physical changes which our globe has undergone, and if, as I also believe to be the case, these changes have not been the cause of the diversity now observed among organized beings, then we may expect from the greater depth of the ocean representatives resembling those types of animals which were prominent in earlier geological periods, or bear a closer resemblance to younger stages of the higher members of the same types, or to the lower forms which take their place nowadays. And to leave no doubt that I have a distinct perception of what I may anticipate, I make the following specific statement.

It lies in the very nature of these animals that, among vertebrates, neither Mammalia nor Birds can exist in deep waters, and if any Reptiles exist there, it could only be such as are related to the extinct types of the Jurassic periods, the Ichthyosauri, Plesiosauri, and Pterodactyles, but even of these there is very little probability that any of their representatives are still alive. Among the fishes, however, I expect to discover some marine representatives of the order of Ganoids of both the principal types known from the secondary zoological period, such as Lepidoids, Sauroids, Pycnodonts, Cœlacanthes, Amioids, and Glyptolepis-like species may even be looked for. Among Selachians some new representatives of Cestraciontes or Hybodontes may be forthcoming, connecting the latter more closely to Odontaspis. I also look forward to finding species allied to Corax, or connecting this genus with Notidanus, perhaps also Jurassic-like forms. Among Chimæroids we may expect some new genera more closely related to the extinct types of that family than those now living. Among ordinary fishes I take it for granted that Beryx genera may be added to our list, approaching perhaps Acanus or rather Sphenocephalus; also types allied to Istieus, to Anenchelum, and to Os-

meroides, Elops, and Argentina. Dercetis and Blochius may also come up. Species of all classes of the animal kingdom which have been very rarely met with by fishermen and naturalists are likely to be found in the deepest waters, in which neither hooks nor nets are generally lowered. Nothing is known concerning the greatest depth at which fishes may live. Upon this point I hope to obtain positive data.

The Mollusks will, no doubt, afford a rich harvest of novelties, among which some may be of the deepest zoological interest. It stands to reason that a variety of Nautiloid Cephalopods may be discovered when Nautilus proper and Spirula are so rarely found alive, and among new forms there may be those combining characters of Argonauts with features of Nautilus; some may even be coiled up like Turrilites. Belemnitic Squids would appear natural. Among Gasteropods we may look for high spired Natica-like types, for representatives of Acteonella, Avellana, and the like; for small Volutoids of the Tertiary and Cretaceous types, for Rostellarias, even for Nerineas, and more particularly for forms intermediate between Firulea and Cyprea. Among Acephala I would expect a variety of Myacea approaching those described in my monographs of that family from the Jurassic and Cretaceous formations, such as Ceromya, Corimya, Circomya, Goniomya, Myopsis, etc., with Panorpa and Pholadomya, and others recalling perhaps also Cardinia, Gresslya, or Cardiacea more closely related to Conocardium than the living species, perhaps leading to Opis, or Trigoniae of extinct types akin to Myophoria, with Pachymya, Diceras, Grammisia, Inoceramus, Pterinea, Monotis and Posidonia. Rudistes should take the place of oysters and the harvest of Brachiopods should be large.

Among Crustacea it is natural to suppose that genera may be discovered reminding us of Eryon or of Pemphyx, Gampsonyx, or some Amphipods, and Isopods aping still more closely the Trilobites than Serolis, or Limuloids approaching that extinct family. The classification, embryology, and order of succession of Echinoderms is now so well known, that it is perhaps still more easy to anticipate the character of discoveries in this branch of the animal kingdom than in any other. I expect confidently, to find Spatangoids approaching Holaster, Toxaster, Ananchytes, Hemipneustes or Metaporhinus, and others akin to Dysaster; Echinolamps approaching Pygurus, Nucleolites tending to Clypeus, Gal-

erites like Pyrina or Globator, etc., etc., and again Cidarid akin to *C. glandifera* and *clavigera* with Glypticus-like species, and Codiopsis, Cœlopleurus, Cyphosoma, and Salenia.

Among Starfishes the types of Goniaster and Luidia are likely to prevail with simple rayed Euryaloid genera, and among Crinoids a variety of genera reminding us of Pentremites, Marsupites, Pentacrinus, Apiocrinus, and Eugeniacrinus.

The question of the affinities of Millepora will probably receive additional evidence, and genera connecting more closely the Rugosa and Tabulata with one another, and with the Acalephs may be expected in the shapes of branching Heliopores and the like.

With the monograph of Pourtales upon the deep-sea corals before me, it would be sheer pretence to say anything concerning the prospect of discovering new representatives of this or that type. His tables point them out already.

But, there is a subject of great interest likely to be elucidated by our investigation,— the contrast of the deep-sea faunæ of the northern with those of the southern hemisphere. Judging from what Australia has already brought us, we may expect to find that the animal world of the southern hemisphere has a more antique character, in the same way as North America may be contrasted with Europe, on the ground of the occurrence in the United States of animals and plants now living here, the types of which are only found fossil in Europe.

A few more words, upon another subject. During the first three decades of this century, the scientific world believed that the erratic boulders, which form so prominent a feature of the surface geology of Europe, had been transported by currents arising from the rupture of the barriers of great lakes among the Alps or started from the north by earthquake waves.

Shepherds first started the idea that within the valleys of Switzerland these huge boulders had been carried forward by glaciers, and Swiss geologists, Venetz and Charpentier foremost among them, very soon proved that this had been the case. This view, however, remained confined to the vicinity of the Alps in its application, until I suggested that the phenomenon might have a cosmic importance, which was proved when I discovered, in 1840, unmistakable traces of glaciers in Scotland, England, and Ireland, in regions which could have had no connection whatever with the elevation of the Alps. Since that time the *glacial period*

has been considered by geologists as a fixed fact, whatever may have been the discrepancies among them as to the extent of these continental masses of ice, their origin, and their mode of action.

There is, however, one kind of evidence wanting to remove every possible doubt that the greatest extension of glaciers in former ages was connected with cosmic changes in the physical condition of our globe. All the phenomena related to the glacial period must be found in the southern hemisphere with the same characteristic features as in the north, with this essential difference, that everything must be reversed; that is, the trend of the glacial abrasion must be from the south northward; the lee side of abraded rocks must be on the north side of hills and mountain ranges, and the boulders must have been derived from rocky exposures lying to the south of their present position. Whether this is so or not, has not yet been ascertained by direct observation. I expect to find it so throughout the temperate and cold zones of the southern hemisphere, with the sole exception of the present glaciers of Terra del Fuego and Patagonia, which may have transported boulders in every direction. Even in Europe, geologists have not yet sufficiently discriminated between local glaciers and the phenomena connected with their different degrees of successive retreat on one hand, and the facts indicating the action of an expansive and continuous sheet of ice moving over the whole continent from north to south. Unquestionably, the abrasion of the summits of the mountains of Great Britain, especially noticeable upon Schiehallion, is owing to the action of the great European ice-sheet during the maximum extension of the glacial phenomena in Europe, and has nothing to do with the local glaciers of the British Isles.

Among the facts already known from the southern hemisphere are the so-called rivers of stone of the Falkland Islands, which attracted the attention of Darwin during his cruise with Captain Fitzroy, and which have remained an enigma to this day. I believe it will not be difficult to explain their origin in the light of the glacial theory, and I fancy now they may turn out to be nothing but ground moraines, similar to the "Horsebacks" of Maine.

You may ask what the question of drift has to do with deep-sea dredging? The connection is closer than may at first appear. If drift is not of glacial origin, but the product of marine currents, its formation at once becomes a matter for the Coast Survey

to investigate, and I believe, it will be found in the end, that, so far from being accumulated by the sea, the drift of the lowlands of Patagonia has been worn away to its present extent by the continued encroachment of the ocean in the same manner as the northern shores of South America and of Brazil have been.

THE BLIND FISHES OF THE MAMMOTH CAVE AND THEIR ALLIES.*

BY F. W. PUTNAM.

THE blind fish of the Mammoth Cave has from its discovery been regarded with curiosity by all who have heard of its existence, while anatomists and physiologists have considered it as one of those singular animals whose special anatomy must be studied in order to understand correctly facts that have been demonstrated from other sources; and, in these days of the Darwinian and development theories, the little blind fish is called forth to give its testimony, pro or con.

Before touching upon this point, however, we must call attention to the structure of the fish and its allies, and to others that are either partially or totally blind.

In the lancelet (Branchiostoma) and the hag (Myxine) the eye is described "as simple in form as that of a leach, consisting simply of a skin follicle† coated by a dark pigment, which receives the end of a nerve from the brain." Such an eye speck as this structure gives would only answer for the simple perception of light. In the young‡ of the lampreys (Petromyzon) the eye is very small and

*It was intended to put this article in the last number of the NATURALIST in connection with the article on the cave and its insect and crustacean life, but the delay in preparing the plates made it necessary to postpone it. We are therefore obliged to refer the reader to the December number for further information of the fauna of the cave and a short account of the cave itself. — EDS.

† See further on where Prof. Wyman questions this structure.

‡ These young lampreys have been described under the generic name of Ammocœtes, and it was not until 1856, when Prof. Müller discovered the fact of a metamorphosis in the lampreys, that their true position was ascertained. Prof. Müller has traced the history of the common European species and shown that it is three or four years in attaining its perfect form. With this fact before us and with the early stages of the Myxinoids still unknown, have we not some reason for suspecting that the Lancelet may yet prove to be a larval form of the Myxinoids, notwithstanding that it is said to lay eggs? Why should we not suspect the existence in the very lowest vertebrates of some-